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In-Situ Real-Time Characterization of Particulate Emissions from a Diesel Engine Exhaust by Laser-Induced Incandescence

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ABSTRACT

Diesel engines face tightening particulate matter emissions regulations due to the environmental and health effects attributed to these emissions. There is increasing demand for measuring not only the concentration, but also the size distribution of the particulates. Laser-induced incandescence has emerged as a promising technique for measuring spatially and temporally resolved particulate volume fraction and size. Laser-induced incandescence has orders of magnitude more sensitivity than the gravimetric technique, and thus offers the promise of real-time measurements and adds the increasingly desirable size and morphology information.

The usefulness of LII as a diagnostic instrument for the precise measurement of particulate concentration and primary particle size has been demonstrated. Measurements have been performed in the exhaust of a single cylinder DI research diesel engine. Simultaneous gravimetric filter measurements were made for direct comparison with the LII technique. Quantitative LII is shown to provide a sensitive, precise, and repeatable measure of the particulate concentration over a wide dynamic range. LII and gravimetric measurements are shown to correlate well over a wide range of operating conditions. A novel method for determining the primary particle size is shown to be precise enough to distinguish particle sizes for different engine operating conditions, and subsequently the number density of primary particles was determined. LII has also been shown to be sensitive in differentiating the PM performance between four different fuels.

The LII technique is capable of real-time particulate matter measurements over any engine transient operation. The wide dynamic range and lower detection limit of LII make it a potentially preferred standard instrument for particulate matter measurements.